Cross-Sectional Household Heterogeneity in the Business Cycle

Gavin Engelstad

Macalester College

Thanks to my advisor Mario Solis-Garcia, committee members Elizabeth Engle and Alisdair McKay, and the Macalester Honors cohort for helpful comments.

Motivation

Motivation

Business cycles are the drivers of short-run macroeconomic fluctuations

Motivation

Business cycles are the drivers of short-run macroeconomic fluctuations

Recent work has found household heterogeneity is important for explaining the aggregate effects of business cycles

- MPC Effects (Bilbiie 2020; Auclert, Bardóczy, and Rognlie 2023)
- Redistribution Effects (Auclert 2019; Bayer, Born, and Luetticke 2024)

Questions

How do business cycle effects differ across the distribution of households?

How are the transmission channels for business cycle shocks different across the distribution?

Model

HANK

I use a Heterogeneous Agent New Keynesian model

HANK

I use a Heterogeneous Agent New Keynesian model

Heterogeneous Agent: Model households differ in their levels of income and wealth

I use a Heterogeneous Agent New Keynesian model

Heterogeneous Agent: Model households differ in their levels of income and wealth

New Keynesian: The model incorporates price and market frictions

Agents

The model has four types of agents

Agents

The model has four types of agents

Households: Choose consumption and savings to maximize utility subject to idiosyncratic income shocks

Agents

The model has four types of agents

Households: Choose consumption and savings to maximize utility subject to idiosyncratic income shocks

Unions: Demand labor from households to maximize aggregate utility

Agents

The model has four types of agents

Households: Choose consumption and savings to maximize utility subject to idiosyncratic income shocks

Unions: Demand labor from households to maximize aggregate utility

Firms: Monopolistically competitive firms produce goods using labor from households to maximize profit

Agents

The model has four types of agents

Households: Choose consumption and savings to maximize utility subject to idiosyncratic income shocks

Unions: Demand labor from households to maximize aggregate utility

Firms: Monopolistically competitive firms produce goods using labor from households to maximize profit

Government: Sets fiscal policy (taxes, transfers, spending, bonds) and monetary policy (interest rate)

Agents

The model has four types of agents

Households: Choose consumption and savings to maximize utility subject to idiosyncratic income shocks

Unions: Demand labor from households to maximize aggregate utility

Firms: Monopolistically competitive firms produce goods using labor from households to maximize profit

Government: Sets fiscal policy (taxes, transfers, spending, bonds) and monetary policy (interest rate)

▸ Households ▸ Unions ▸ Firms ▸ Government

Shocks

Business cycles deviations are caused by shocks to

- TFP (A_t)
- Price Markups (ψ_t)
- Wage Markups (ψ_t^W)
- Government Spending (g_t)
- Monetary Policy (ξ_t)
- Tax Progressivity (τ_t^P)
- Transfers (η_t)

Equilibrium

The model has markets for

- Goods
- Labor
- Bonds

Competitive equilibrium means all three markets clear

▸ Clearing Conditions

Parameterization

Approach

“Calibrate, then estimate”

Approach

"Calibrate, then estimate"

1. Calibrate micro-parameters
2. Estimate shocks

Winberry (2018), Auclert, Rognlie, and Straub (2020), and Bayer, Born, and Luetticke (2024)

Estimation Strategy

Assume a Gaussian AR(1) process for each shock with

ρ Persistence $\in (0, 1)$

σ Standard Deviation $\in (0, \infty)$

Estimation Strategy

Assume a Gaussian AR(1) process for each shock with

- ρ Persistence $\in (0, 1)$
- σ Standard Deviation $\in (0, \infty)$

Perform a Bayesian estimation in the sequence space

Data

Fit the model to seven detrended time series from FRED

- GDP (Y_t)
- Inflation (π_t)
- Federal Funds Rate (I_t)
- Hours Worked (N_t)
- Consumption (C_t)
- Debt (B_t)
- Wages (W_t)

Data

Fit the model to seven detrended time series from FRED

- GDP (Y_t)
- Inflation (π_t)
- Federal Funds Rate (I_t)
- Hours Worked (N_t)
- Consumption (C_t)
- Debt (B_t)
- Wages (W_t)

No Microdata!

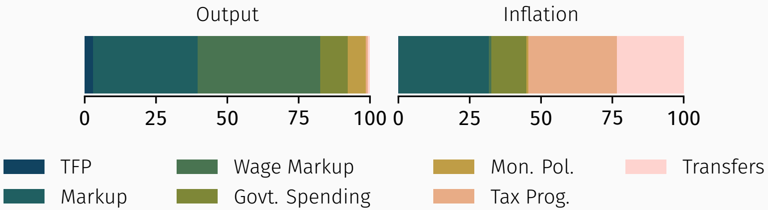
Business Cycles

Estimated Business Cycles

Within the estimated business cycles in the model, each series is affected by different shocks

▸ Estimated Parameters

Aggregates



Forecast error variance decompositions calculated at a 4 quarter time horizon

Household Decisions

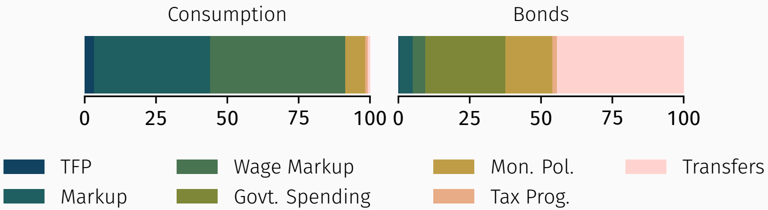
Business cycles affect household consumption and savings decisions

Household Decisions

Business cycles affect household consumption and savings decisions

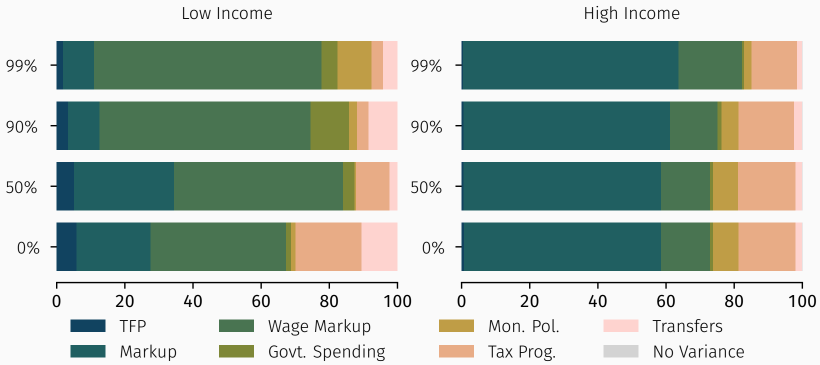
Compare the factors that affect low and high income households at the 0th, 50th, 90th, and 99th wealth percentiles

Household Aggregates



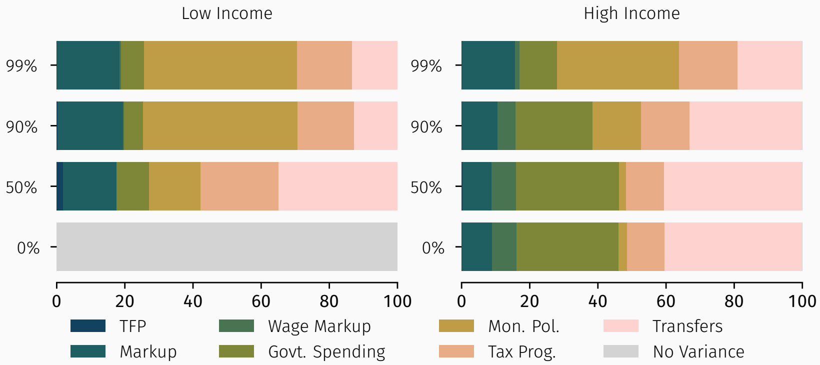
Forecast error variance decompositions calculated at a 4 quarter time horizon

Consumption Decisions



Forecast error variance decompositions calculated at a 4 quarter time horizon

Savings Decisions



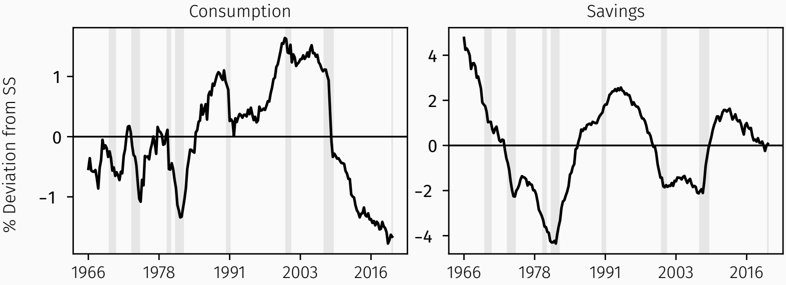
Forecast error variance decompositions calculated at a 4 quarter time horizon

Historical Decompositions

Historical Decompositions

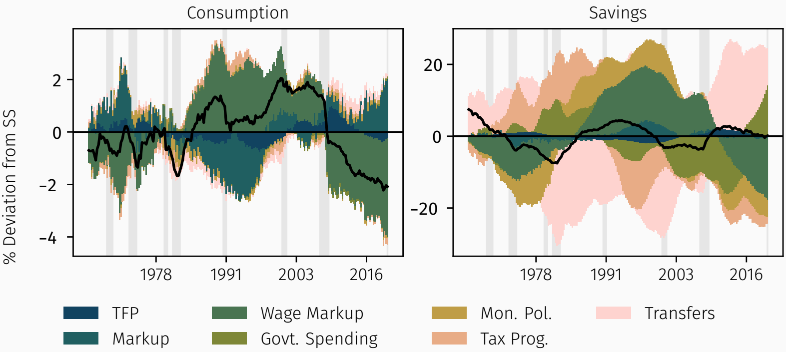
Solve for a sequence of shocks to the model that match the observed data

Data



NBER-dated recessions highlighted in gray

Decomposition

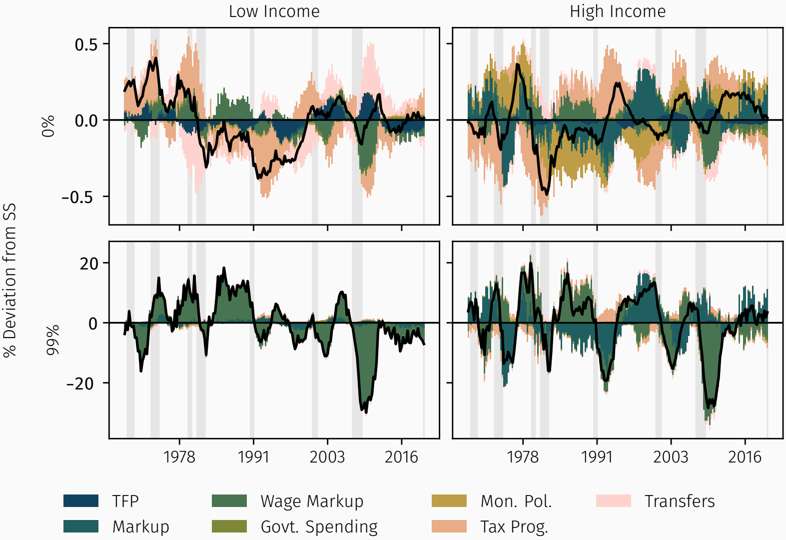


NBER-dated recessions highlighted in gray

Simulation

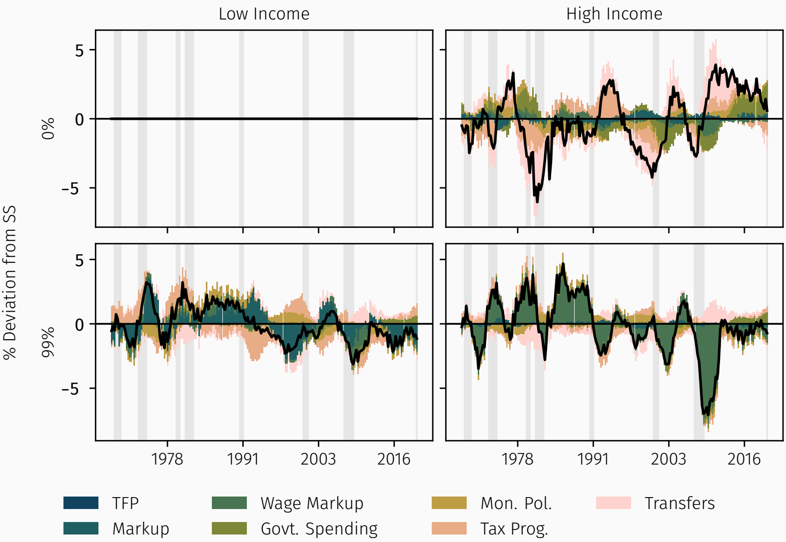
Using the series of shocks, simulate different household's responses

Consumption



NBER-dated recessions highlighted in gray

Savings



NBER-dated recessions highlighted in gray

Conclusion

Findings

1. Household consumption decisions are affected differently by business cycles across income levels

Findings

1. Household consumption decisions are affected differently by business cycles across income levels
2. Changes in savings decisions vary the most across wealth levels

Findings

1. Household consumption decisions are affected differently by business cycles across income levels
2. Changes in savings decisions vary the most across wealth levels
3. The shocks that affect different households vary

   Low Income/Wealth: Wage Markups, Transfers, Tax Progressivity

   High Income/Wealth: Price Markups, Govt. Spending, Monetary Policy

Findings

1. Household consumption decisions are affected differently by business cycles across income levels
2. Changes in savings decisions vary the most across wealth levels
3. The shocks that affect different households vary

   Low Income/Wealth: Wage Markups, Transfers, Tax Progressivity

   High Income/Wealth: Price Markups, Govt. Spending, Monetary Policy
4. During the the 80s, the effects of business cycle factors flipped

Thanks!

Gavin Engelstad

gengelst@macalester.edu

Households (1/2)

Households indexed $i \in [0,1]$ choose consumption $(c_{i,t})$ and savings $(b_{i,t})$ to maximize CRRA utility

$$\max_{\{c_{i,t}, b_{i,t}\}_{t=0}^{\infty}} \quad \mathbb{E} \sum_{t=0}^{\infty} \beta^t \left[\frac{c_{i,t}^{1-\gamma}}{1-\gamma} - \phi \frac{\ell_{i,t}^{1+\chi}}{1+\chi} \right]$$

subject to the budget constraint

$$b_{i,t} + c_{i,t} = \underbrace{R_t b_{i,t}}_{\text{Savings}} + \underbrace{W_t z_{i,t} \ell_{i,t}}_{\text{Income}} + \underbrace{D_t}_{\text{Dividends}} + \underbrace{\eta_t}_{\substack{\text{Govt.} \\ \text{Transfers}}} - \underbrace{\tau_t^L z_{i,t}^{\tau_t^P}}_{\text{Taxes}}$$

and idiosyncratic productivity

$$\log z_{i,t} = \rho_z \log z_{i,t-1} + \epsilon_{i,t}, \quad \epsilon_{i,t} \sim N(0, \sigma_z^2)$$

Households (2/2)

Assume Households follow decision rules based on their states $b_{i,t-1}$ and $z_{i,t}$ so that

$$b_{i,t} = b_t(b_{i,t-1}, z_{i,t})$$
$$c_{i,t} = c_t(b_{i,t-1}, z_{i,t})$$

The distribution of households $\Gamma_t(b, z)$ is

$$\Gamma_{t+1}(b', z') = \int_{\{(b,z):b_t(b,z)=b'\}} \Pr(z' \mid z) d\Gamma_t(b, z)$$

Back

Unions (1/3)

The union block has a labor packer and unions indexed $k \in [0, 1]$

Labor packer aggregates each union's labor using a Dixit-Stiglitz aggregator

$$N_t = \left(\int_0^1 n_{k,t}^{\frac{1}{\psi_t^W}} \right)^{\psi_t^W}$$

Demand

$$n_{k,t} = N_t \left(\frac{w_{k,t}}{W_T} \right)^{\frac{\psi_t^W}{1-\psi_t^W}}$$

Unions (2/3)

Unions demand labor $\ell_{k,t}$ uniformly from households so

$$n_{k,t} = \int z\ell_{k,t} d\Gamma_t^z(z)$$

Decide $\ell_{k,t}$ to maximize aggregate utility subject to quadratic adjustment costs (in utils)

$$m_{k,t}^W = \frac{\psi_t^W}{\psi_t^W - 1} \frac{1}{2\kappa^W} \log\left(\frac{w_{k,t}}{\overline{\pi}^W w_{k,t-1}}\right)^2$$

Unions (3/3)

Wage Philips Curve:

$$\log\left(\frac{\pi_t^W}{\overline{\pi}^W}\right) = \kappa^W\left(\phi L_t^{1+\chi} - \frac{W_t L_t}{\psi_t^W}\int zc_t(b,z)^{-\gamma} d\Gamma_t(b,z)\right) + \beta\log\left(\frac{\pi_{t+1}^W}{\overline{\pi}^W}\right)$$

▸ Back

Firms (1/3)

The firm block has a competitive final goods firm and monopolistically competitive intermediate goods firms indexed $j \in [0, 1]$

The final goods firm aggregates intermediate goods using a Dixit-Stiglitz aggregator

$$Y_t = \left(\int_0^1 y_{j,t}^{\frac{1}{\psi_t}} dj \right)^{\psi_t}$$

Demand

$$y_{j,t} = Y_t \left(\frac{p_{j,t}}{P_t} \right)^{\frac{\psi_t}{\psi_t - 1}}$$

Firms (2/3)

Intermediate goods firms use labor $n_{j,t}$ to produce their intermediate goods according to

$$y_{j,t} = A_t n_{j,t}$$

Face quadratic adjustment costs

$$m_{j,t} = \frac{\psi_t}{\psi_t - 1} \frac{1}{2\kappa} \log\left(\frac{p_{j,t}}{\overline{\pi} p_{j,t-1}}\right)^2$$

Firms (3/3)

Philips Curve:

$$\log\left(\frac{\pi_t}{\overline{\pi}}\right) = \kappa\left(\frac{W_t}{A_t} - \frac{1}{\psi_t}\right) + R_{t+1}^{-1}$$

Profits are paid out as dividends $d_{j,t}$ where

$$d_{j,t} = \frac{p_{j,t}}{P_t} y_{j,t} - W_t n_{j,t} - m_{j,t}$$

Back

Government (1/2)

As the fiscal authority, the government spends, taxes, sells bonds, and taxes households

Spending rule:

$$G_t = g_t Y_t$$

Bond law of motion:

$$B_t = \overline{B} + \rho_B \left(\underbrace{R_t B_{t-1} - \overline{RB} + G_t - \overline{G} + \eta_t - \overline{\eta}}_{\text{Out of Steady State Spending}} \right)$$

Budget:

$$\underbrace{R_t B_{t-1} + G_t + \eta_t}_{\text{Spending}} = \underbrace{\tau_t^L \int z^{\tau_t^P} d\Gamma_t^z(z) + B_t}_{\text{Income}}$$

Government (2/2)

As the fiscal authority, the government sets the interest rate

Taylor Rule:

$$I_t = \bar{I}\left(\frac{\pi_t}{\overline{\pi}}\right)^{\omega_\pi}\left(\frac{Y_t}{\overline{Y}}\right)_t^{\omega_Y}\xi_t$$

Fisher relation:

$$R_t = \frac{I_{t-1}}{\pi_t}$$

▸ Back

Competitive Equilibrium

Goods market clearing means consumption, government spending, and adjustment costs equal output

$$Y_t = \int c_t(b, z) d\Gamma_t(b, z) + M_t + G_t$$

Labor market clearing means unions provide the labor used by firms

$$N_t = \int_0^1 n_{j,t} dj$$

Bond market clearing means the government supplies bonds saved by households

$$B_t = \int b_t(b, z) d\Gamma_t(b, z)$$

▸ Back

Estimation Results

Parameter		Prior			Posterior			
Shock	Statistic	Distribution	Mean	Std. Dev.	Mode	Mean	5%	95%
TFP	ρ	Beta	0.50	0.15	0.953	0.952	0.934	0.969
	σ	Inv. Gamma	0.20	2.00	0.152	0.153	0.142	0.166
Markup	ρ	Beta	0.50	0.15	0.986	0.984	0.971	0.993
	σ	Inv. Gamma	0.20	2.00	0.549	0.554	0.507	0.607
Wage Markup	ρ	Beta	0.50	0.15	0.998	0.998	0.998	0.998
	σ	Inv. Gamma	0.20	2.00	1.753	1.759	1.619	1.912
Govt. Spend	ρ	Beta	0.50	0.15	0.857	0.854	0.806	0.904
	σ	Inv. Gamma	0.20	2.00	0.647	0.652	0.576	0.705
Mon. Pol.	ρ	Beta	0.50	0.15	0.633	0.629	0.576	0.678
	σ	Inv. Gamma	0.20	2.00	0.440	0.444	0.409	0.483
Tax Prog.	ρ	Beta	0.50	0.15	0.907	0.907	0.876	0.936
	σ	Inv. Gamma	0.20	2.00	1.828	1.820	1.476	2.213
Transfers	ρ	Beta	0.50	0.15	0.849	0.842	0.781	0.909
	σ	Inv. Gamma	0.20	2.00	2.374	2.455	2.087	2.844

Back

Auclert, Adrien. 2019. "Monetary policy and the redistribution channel." *American Economic Review* 109 (6): 2333–2367.

Auclert, Adrien, Bence Bardóczy, and Matthew Rognlie. 2023. "MPCs, MPEs, and multipliers: A trilemma for New Keynesian models." *Review of Economics and Statistics* 105 (3): 700–712.

Auclert, Adrien, Matthew Rognlie, and Ludwig Straub. 2020. *Micro jumps, macro humps: Monetary policy and business cycles in an estimated HANK model.* Technical report. National Bureau of Economic Research.

References ii

Bayer, Christian, Benjamin Born, and Ralph Luetticke. 2024. "Shocks, frictions, and inequality in US business cycles." *American Economic Review* 114 (5): 1211–1247.

Bilbiie, Florin O. 2020. "The new Keynesian cross." *Journal of Monetary Economics* 114:90–108.

Winberry, Thomas. 2018. "A method for solving and estimating heterogeneous agent macro models." *Quantitative Economics* 9 (3): 1123–1151.